Make the Design do the Work

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Improving the clarity of games allows players to spend more of their mental effort on strategic planning rather than the mundane bookkeeping of calculating legal moves. This article discusses techniques for achieving this, by making the design do the work rather than the player, and demonstrates this concept through example. Such techniques include visual design, simplifying rules, clarifying rules, harnessing emergent strategies, and minimising mental bookkeeping.

1 Introduction

THIS issue's game design pattern deals with the notion of making the design do the work rather than the player. The aim is to free the player from the mundane bookkeeping of move-making, so that they can focus on the more interesting task of deciding which moves to make. This paper outlines relevant principles, then demonstrates these in relation to numerous examples and counterexamples from well-known – and some lesser-known – games and puzzles.

1.1 Transparency of Rules

The related concept of *embedding the rules* of a game to improve its design is treated in an earlier paper [2]. While there is overlap between the two concepts, embedding the rules is actually a subset of the broader aim of making the design do the work, which can take other forms such as even *increasing* the complexity of rule sets in order to benefit the player. Embedding the rules aims to minimise the number of rules that players must learn, while making the design do the work aims to minimise the mental effort that players must expend in order to play the game. This is the difference between the *clarity* of a rule set (form) and the clarity of moves in action and their implications (function) [5].

The assumption here is that the rules of a game should be as transparent as possible, so as not to distract players from strategic planning. We want the mechanisms of play to be as *clear* as possible so that players can see far down the game tree [3]. However, this is not true for all types of games; e.g. many war games are measured by the complexity and quality of the simulated battle experience rather than their strategic depth. War gamers may recognise this as the distinction between *design for cause* – focussing on the detail – and *design for effect* – abstracting away the detail in favour of higher-level control.

1.2 Design for Cause and Effect

This distinction between design for cause and design for effect was first described in the seminal 1978 article 'Game Design: Art or Science' [4] in relation to two popular board war games of the time, and the merits of each side have been debated ever since. Game designer Alan Emrich later defined these terms as follows:[1]

Design for Cause: When a game's design has players follow all of the logical steps and procedures to obtain an outcome, when players experience a methodology and must consider its many facets. This can often lead to systems that are over-engineered. *That is, when the players are doing all the work and the designer is having all the fun.*

Design for Effect: When a game abstracts complex procedures for simplicity's sake so that the players can get straight to the 'boom'. *That is, when the designer does all the work so the players can have all the fun.*

Both philosophies have their proponents, although I personally find the latter more compelling and believe that it has broader relevance to many more types of games and puzzles, so will focus on that approach here. This paper could just as well be called 'Designing for Effect'.

1.3 Perceived Affordance

Design researcher Don Norman identifies three basic principles for the design of effective user controls [5]:

1. *Visibility*: It should be obvious what a control is used for.
2. *Affordance:* It should be obvious how a control is used.
3. *Feedback*: It should be obvious when a control has been used.

[1] Emrich's 'Game Glossary' web site that contains these definitions is no longer available. Note that the exact meanings of these terms are *still* being debated online: https://boardgamegeek.com/thread/1668036/design-effect

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The relevance of these principles to video game design has been observed [6]. In the context of board games and puzzles, the second concept of *affordance* is probably the most useful. The concepts of *visibility* and *feedback* are less relevant, as game components tend to be clearly visible and it is generally obvious when they have been used, as they have moved, rotated, flipped, promoted, etc.

The term *affordance* comes from psychology [7] where it refers to the actionable properties between the world and an actor. These properties are fundamental to the actor's nature and do not need to be visible, known or even desirable.[2]

Norman points out that when it comes to design, we are really interested in the *perceived affordance* of objects, i.e. how the user understands and uses them rather than what is actually true. There is an obvious correlation between perceived affordance and making the design do the work in games; we want the player to intuitively know what actions are available in any given situation, rather than having to expend undue mental effort to derive this knowledge.

2 Visual Design

A game's appearance is what shapes a player's first impressions, before they learn its mechanisms and behaviour through play. This offers considerable scope for perceived affordance as the visual features of a game are typically its most obvious. This section gives examples of effective visual design.

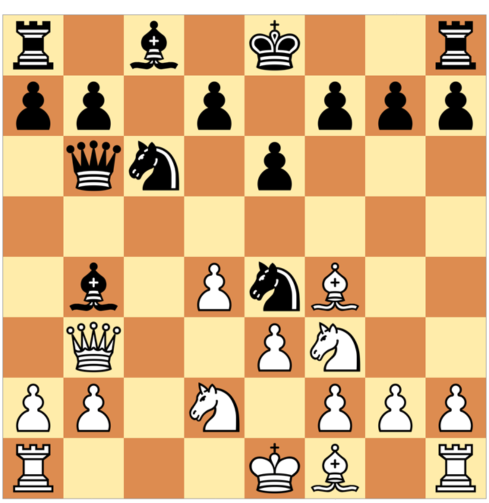

Figure 1. Chess position on a chequered board.

2.1 Chess

The chequered 8×8 square board, shown in Figure 1, will be familiar to most readers as the Chess or Draughts board. But what happens if we replace this board with a plain lined grid?

Figure 2 shows the result of transposing this same Chess position to such a uniform grid. Functionally there is no difference; the geometries of the two boards are identical, the technical aspects of play are not affected, and the same rules of movement still apply.

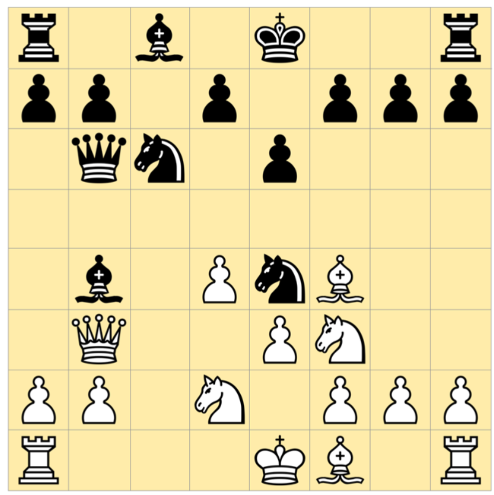

Figure 2. Chess position on a lined grid.

However, the reader might find the position harder to interpret on the unadorned lined grid. If one studies each piece in isolation then its moves are still obvious, but the overall position takes longer to understand at a single glance.

This is more than just a side-effect of seeing familiar pieces transposed to an unfamiliar board. The alternating cell colours make it easier to see at a glance which pieces on the far side of the board are under diagonal attack, which are the 50% of cells potentially threatened by a single bishop, and which squares each knight can potentially move to (they will be squares of the other colour). The chequered board colouring is an example of a design feature that is independent of the game's rules and exists only to help the player.

2.2 Vault

This principle is extended in the recent game Vault, by designer Néstor Romeral Andrés, in which pieces can either move to an adjacent cell or 'vault' over a pivot piece of the same colour to the symmetrically situated cell beyond it, possi-

[2] Norman, D., 'Affordances and Design': http://www.jnd.org/dn.mss/affordances_and.html

[3] http://www.nestorgames.com/rulebooks/VAULT_EN.pdf

bly to capture an enemy piece.[3] Figure 3 shows a typical jump move by White.

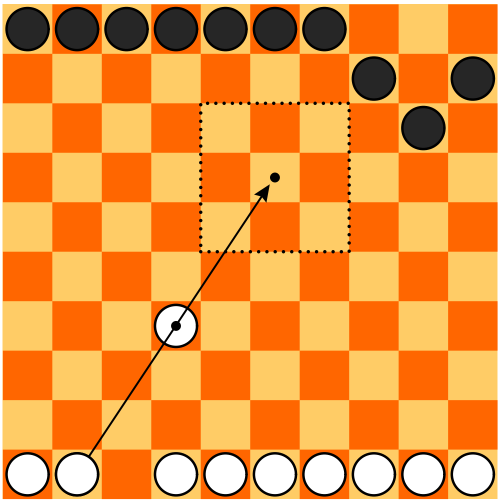

Figure 3. A jump move in Vault.

Pieces may move to a neighbouring cell of either colour, but will *always* jump to a cell of the same colour. This reduces the mental burden on the player by making it easier to identify the correct target cell for long distance vaults, as only five out of the nine cells in the 3×3 *landing window* (i.e. the destination cell and its immediate neighbours) will be the jump colour.

Game designer Ken Shoda took this idea a step further to suggest the colouring scheme shown in Figure 4. Only *one* of the nine cells in the 3×3 landing window will be the jump colour using this design, making jump targets even easier to locate. Players can spend less time working out where their jumps will land and more time on planning.

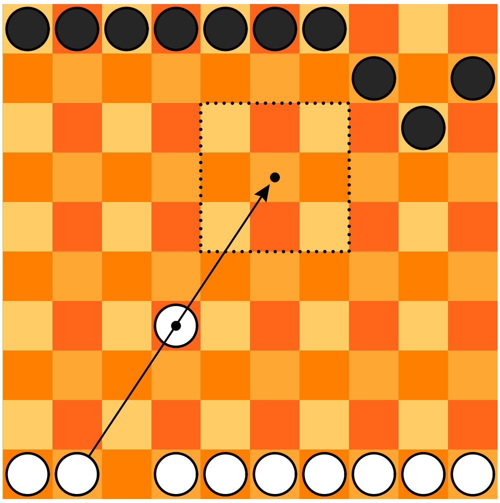

Figure 4. A jump on the improved Vault board.

2.3 Heptalion

The domino-like game Heptalion, described in a previous paper [2], demonstrates how the visual design of pieces can help the player. Figure 5 shows a partially solved Heptalion challenge, in which the (single) player must place the tiles on the right to cover the pattern shown on the left, such that all symbols match. Two tiles have been played so far in this example.

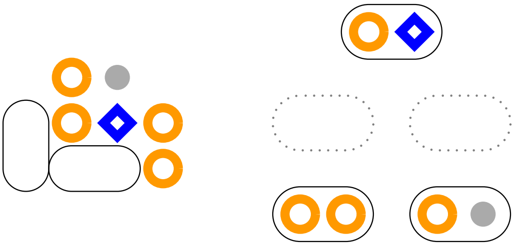

Figure 5. A partially solved Heptalion puzzle.

Note that tiles are placed face-down and that their backs are blank. This is not coincidence or cost-saving on paint; it is an effective design feature to occlude completed parts of the pattern from view. The game was originally played by placing tiles onto the pattern face-up so that the symbols still showed, but this led to confusion between which tiles were covered and which were not, interfering with the solver's planning. The simple insight to place tiles face-down led to a dramatic improvement for the player.

This case is unusual in that the design is improved by *removing* information from pieces rather than adding information to them. For comparison, see [2] for examples of effective design based on embedding visual cues or instructions in the equipment.

3 Simplifying Rules

Moving from the visual to the conceptual, careful design can also simplify a game's rule set, to reduce the number of rules and the resulting cognitive burden on the player.

3.1 Pentalath

The board game Pentalath, invented by the computer program LUDI in 2007 [8], is played on the unusual hexagon-based board shown in Figure 6. Players take turns placing a piece of their colour with the aim of forming 5-in-a-row of their colour, while obeying the surround capture rule of Go.

Surround capture on a square grid suffers from the problem of mutually supporting patterns that create infinite cycles of play in which pieces are captured and recaptured indefinitely, unless special *ko* or *superko* rules are invoked to stop such repetitions from occurring. However, such *ko* cycles do not occur on the hexagonal grid, as discussed in [9] and shown in Figure 6, where it is obvious that a white piece played at cell x can not immediately be recaptured by Black.

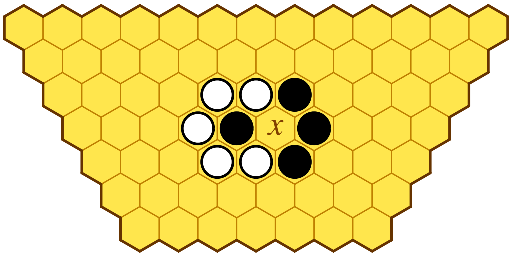

Figure 6. No *ko* on the hexagonal grid.

LUDI had inadvertently (re)discovered this useful feature of the hexagonal grid through trial and error, allowing it to present a simplified rule set derived from Go that did not involve any form of *ko* rule. This made move planning easier for players, as it removed the need to constantly check for repetitions of previous board states. This feature was apparently known amongst Go players who had experimented with hexagonal versions of the game, but had not previously been documented in the literature to my knowledge.

3.2 XOXO

XOXO, shown in Figure 7, is a tile placement puzzle from Smart Games designed by Raf Peeters.[4] Players are given a number of challenges, each showing a number of preplaced hint pieces, and must pack the remaining pieces into the rectangular grid.

Figure 7. An XOXO challenge in progress.

This style of puzzle has a long history and will be well known to most readers, but XOXO features a couple of interesting innovations. Each piece is a *polyomino* made from five connected squares, each with a prominent O ring on one side and X-shaped protrusion on the other, in an alternating pattern. The board has prominent bumps on alternating cells – as can be seen in the figure – over which the O rings fit snugly but the X protrusions cannot be placed. Pieces can therefore only be placed on the board in precise orientations and locations, to make an alternating 'XOXO. . . ' pattern, and pieces can not accidentally be placed at an angle.

This design adds some interesting deductive aspects to the game to help players. First, pieces must be placed to fit not only the other pieces but also the bumps on the board, giving players extra information to work with. Second, the fact that each piece has an odd number of squares means that each piece has a different number of O and X shapes on each side. Players can therefore often deduce which side up the remaining pieces must be placed, based on the number of exposed bumps remaining on the board; if there are N bumps visible, then the remaining pieces must have N X shapes uppermost. These implicit constraints allow challenges to be constructed with very few predefined hint pieces but which are still fully deducible.

XOXO shows how clever design can bring with it a number of useful constraints implicit in the equipment, without the need to explicitly state additional rules and strategies.

3.3 Unico

Figure 8 shows a mockup of a smartphone puzzle game currently under development called Unico. The rules are decidedly simple:

> Swap and rotate tiles to create one path of a single colour.

Figure 8 shows the last two moves in the solution of a Unico challenge. Tiles *a* and *b* and swapped (left), then tile *c* is rotated 180° to complete a path of a single colour.

At the lower (mechanical) level, the program makes things easier for the player by updating path segment colours as tiles are moved. Path segments moved to connect to one or more neighbouring segments are set to the same colour, and path segments whose connections are broken take on new distinct colours. Thus, every connected subpath always has its own distinct colour.

[4] http://www.smartgames.eu/en/smartgames/iq-xoxo

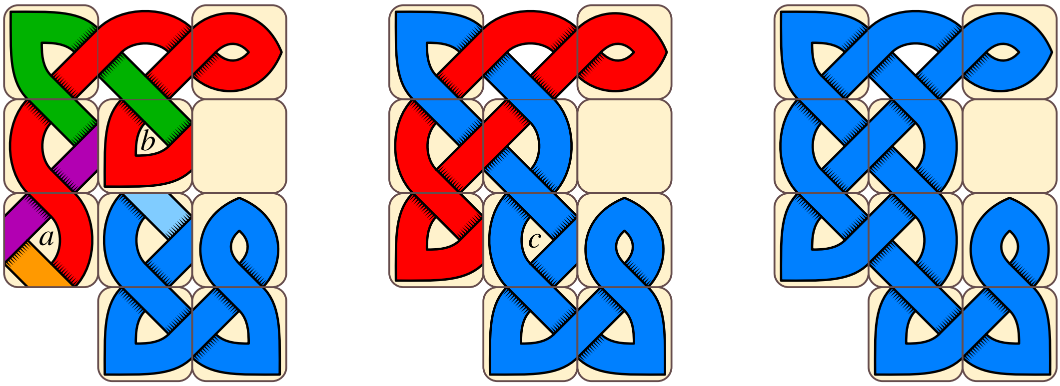

Figure 8. Final moves of a game of Unico. Swapping tiles *a* and *b* then rotating *c* completes a single path.

At the higher (conceptual) level, colour coding connected subpaths in this way makes it easier for the player to understand game states than trying to follow the convoluted paths by shape alone. This makes the game more intuitive, as it is natural for the player to seek moves that create fewer colours, which create fewer (and longer) subpaths, which progresses towards the goal.

This is perceived affordance in action; the player need not understand that they are pursuing the implicit topological goal of completing a single connected path in order to play the game effectively. This saves the need to explicitly state this as a rule, simplifying things for the player.

Note that two of the cells in each state are 'flat' and do not have a tile drawn behind them. This is another visual cue to the player that these are fixed cells that cannot be swapped or rotated, without the need to explicitly state this in a rule.

3.4 Gloop

Sometimes, the design of a game can decide certain quantities or limits that might otherwise be based on arbitrary choices: *How big should the board be? How many pieces should each player start with? Which tiling is best?* And so on.

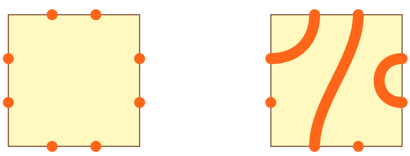

Figure 9. The tile basis and a Gloop tile.

Consider the puzzle game Gloop by renowned Dutch designer Fred Horn. Figure 9 (left) shows a square tile with two equidistant points on each side, and Figure 9 (right) shows one way that paths can be drawn within the tile to connect different points such that no paths intersect. The Gloop set consists of 91 such tiles, representing all topologically unique ways that such paths can be drawn within a square tile (including the empty tile). The complete set of 91 tiles can be found in the official rule book.[5]

A number of puzzles can be played with the Gloop tiles, the most interesting of which I find to be the task of creating patterns that form a single closed contour. For example, Figure 10 shows a 3×3 group of tiles that form a single closed contour. This task gets increasingly difficult for increasing numbers of tiles, and has in fact been proven impossible for 88 tiles or more [11].

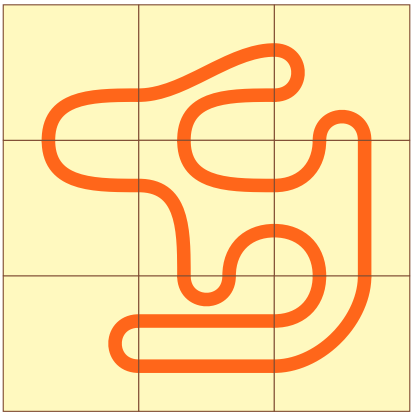

Figure 10. A closed 3×3 Gloop shape.

Starting with square tiles as a basis, how did Horn decide that they should have two dots per side or that there should be exactly 91 tiles? These parameters were not decided by him, but by the underlying mathematics of the design; this combination of features produced the optimal set in terms of size, complexity and playability [11], and has the mathematical purity of a complete set.

[5]http://nestorgames.com/rulebooks/GLOOP_EN.pdf

Even the size of the playing area was predefined for Horn. Most of his challenges involve placing all 91 tiles in a rectangle to satisfy certain criteria. Of the two discrete rectangles that can be constructed with 91 squares – 1×91 and 7×13 – a moment's reflection should reveal that 1×91 is an unsuitable number (unless we allow open path ends) hence 7×13 is the standard size. This is a case of the design making things easier for the designer as much as for the player.

3.5 Xats

Xats pieces are the unusual shapes shown in Figures 11 and 12, formed by circles with up to six spikes radiating in each of the six hexagonal directions. They are produced as off-cuts from the hexagonal tile game Stax,[6] and have themselves been developed into their own game. The rules are given in [10] and on the Xats web site.[7]

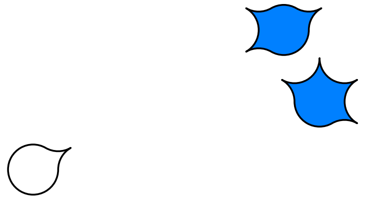

Figure 11. Which piece is white pointing at?

An inherent problem with Xats pieces is that they have a hexagonal basis but are difficult to line up in a hexagonal formation, even if placed adjacent to each other; the slightest misalignment or error in rotation leads to ambiguity. For example, the pieces shown in Figure 11 are placed in an implied hexagonal grid such that the white piece points to one of the blue pieces, but it is not clear which one. Such ambiguity can only confuse players and detract from the playing experience.

For this reason, designer Néstor Romeral Andrés abandoned the obvious 2D grid format – as used in the parent game Stax – and instead proposed using independent 3D stacks of pieces, as shown in Figure 12. Each turn, players choose a piece from their hand (top and bottom rows) to add to a stack in the shared play area (centre row), such that the piece's spikes cover the spikes of existing pieces in that stack.

This not only side-steps the problem of ambiguous grid alignment, but also enforces accuracy in rotation, as players must align each piece with existing pieces in the stack. The game's rules were simplified by exploiting the unique piece design to allow intuitive and error-free moves that are clear to players.

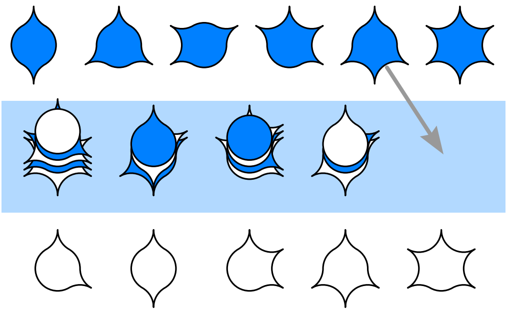

Figure 12. A Xats game in action.

However, this is not the only way in which the design was made to do the work in this game. A subsequent rule was added that allows players to discard one of their pieces and destroy a stack of the same height as the piece's spike count, returning the stack pieces to their owners. This rule made games longer and more interesting, fit with the game's general theme of recycling, and was carefully implemented to avoid cycles in play.

4 Clarifying Indicators

The previous Xats example demonstrated not only how the design can be used to simplify the rules, but conversely how additional rules can be added to clarify matters for the player. This section contains examples of the related notion of *clarifying indicators*, which are non-essential rules or design elements added to a game in order to improve the experience for players.

4.1 Catchup

In the game Catchup, by Nick Bentley, the number of pieces to be played each turn depends on both players' largest group sizes [12]. This has the potential to distract players from the core task of move planning, if they must constantly monitor and recount group sizes just to determine the legal moves each turn.

For this reason, a scoring track was added around the board, as shown in Figure 13, on which players advance pieces of their colour to indicate their largest current group sizes. This enhancement is not essential to the game, but provides this key information to players at glance, simplifying the task of calculating legal moves.[8]

[6] http://nestorgames.com/rulebooks/STAX_EN.pdf
[7] http://nestorgames.com/rulebooks/XATS_EN.pdf
[8] Such scoring tracks are known as *Kramerleisten*, after Wolfgang Kramer, who used them in many of his designs.

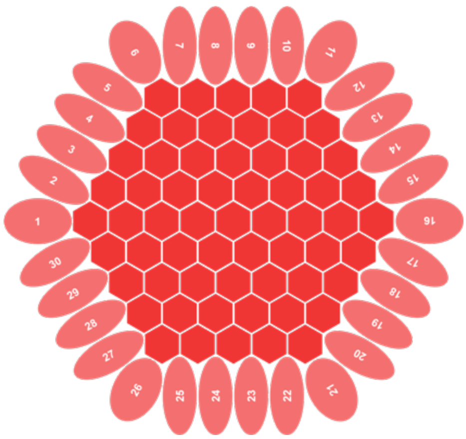

Figure 13. Catchup board with scoring track [12].

4.2 Amazons

Sometimes explicitly restating an obvious rule can help clarify matters for the player. For example, in the game Amazons, by Argentinian designer Walter Zamkauskas, shown in Figure 14, players move one of their Amazons each turn like a queen in Chess, then fire an arrow from the new location in any of the eight cardinal directions to land as far as desired in its direction of travel, in another queenlike move. There is no capture and Amazons can not move onto any square already occupied by any other piece. The game is won by the last player able to move.

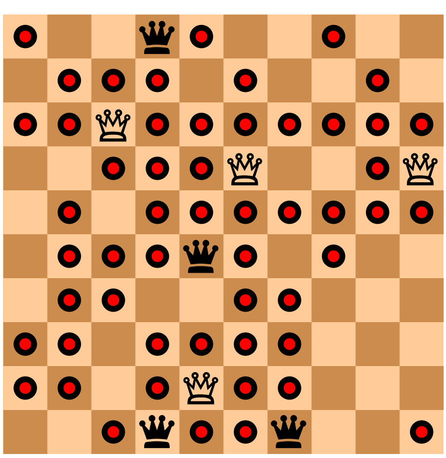

Figure 14. Black will win this game of Amazons

The first thing to note in the context of this discussion is that the firing of arrows creates walls that introduce an aspect of territorial connection [13] and ensure that every game converges steadily to a resolution. The design brings to the game implicit mathematical complexity in a simple and intuitive manner.

[9] Personal correspondence.

The second thing to note is that the rules almost always include the clarification that the arrow can be fired back over the cell just vacated by its firer. This rule is superfluous – it is implied by the fact that the arrow can be fired in any of the eight cardinal directions – but it is still useful in removing *any* doubt in the player's mind. If the player had to constantly deduce for themselves 'yes, arrows can move back over the cell just vacated' with every move then even that minor niggle has the potential to interfere with their move planning thought processes.

While I personally prefer elegant minimal rule sets, and avoid restating obvious rules where possible, this is warranted in cases where such clarifications could avoid potential misinterpretations by players. I have been surprised over the years by the number of ways in which players have found to misunderstand the rules of my own games, making me reevaluate my assumptions about what can and cannot be obviously deduced from a given set of rules. Clarifying such potential ambiguities is a simple way to make the rules do the work rather than the player.

4.3 Meaningful Names

German mathematician Ingo Althöfer suggests that even a carefully chosen name can make a game easier for players to understand and play, if it mentally prepares them for the concepts involved.[9] For example, players might guess that the game Knight's Tour involves moving a familiar knight piece on a tour of a chessboard, before even seeing the equipment and rules.

This preference for meaningful names applies to many well-known games. The traditional game Snakes and Ladders was released by Milton Bradley as Chutes and Ladders, making the principles involved even more obvious to players; you get what it says on the box. Players do not need reminding that the aim of the card game Five Hundred is to score 500 points. And there can be no doubt regarding the aim and general theme of Monopoly.

5 Emergent Strategies

While clarifying indicators explicitly help players, strategies that emerge from the play itself can implicitly help by providing clear plans of action to follow. Players are motivated to search for and follow such strategies for their own benefit rather than due to any expressed rules, and a game's design will ideally provide ample scope for such implicit strategies to emerge naturally.

5.1 Omega

In the game Omega, each player's score is given by the product of the sizes of each group of their colour [14]. For example, Figure 15 shows a four-player game on a size-5 board, in which the current scores are:

White:	$1\times2\times2\times3\times4$	=	48
Black:	$1\times4\times7$	=	28
Red:	$1\times2\times4\times5$	=	40
Blue:	$1\times2\times3\times6$	=	36

Omega originally suffered from a lack of clarity, as the need to multiply lists of group sizes after each move imposed a computational burden on the players that made move planning difficult, especially on larger boards. This led to unsatisfactory games in which players made moves without fully understanding their implications, and often nobody would know who was winning until the final score calculation at the game's end.

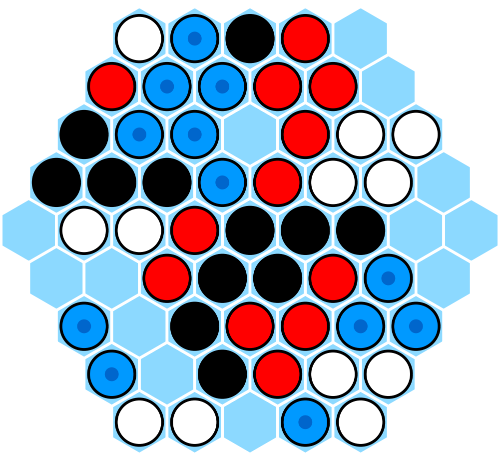

Figure 15. An Omega position... who is winning?

These problems were neatly solved following an observation by designer Néstor Romeral Andrés that the optimal group size for maximising a player's score is 3 [14]. This led to a simple strategy that suddenly threw the game wide open and introduced subtle tactics of connection and disconnection, as players sought to make their own groups of size 3 while preventing their opponents from doing the same. The design produced an emergent strategy that saved the game.

5.2 Slitherlink

Solution strategies are essential for logic puzzles and elevate them above mere exercises in combinatorial exhaustion. For example, Figure 16 shows one of the local solution patterns useful for the deduction puzzle Slitherlink [15], in which a simple closed path must be traced through orthogonal vertices of a square grid to visit the number of sides indicated on each numbered cell.

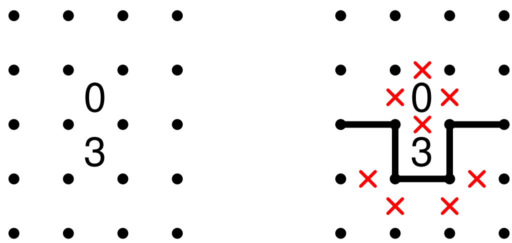

Figure 16. An emergent pattern in Slitherlink

Slitherlink players will soon learn that such adjacent `03` pairs always produce the pattern of cuts and edges shown, which can be used as building blocks – along with other patterns – to aid solution for a more engaging playing experience. If the player must instead laboriously recreate the deductions that led to this pattern every time they see a `03` pair, then this will become tiresome very quickly. The designer should do the work of encoding such patterns in their challenges, so the player can have the more entertaining task of recognising and exploiting them.

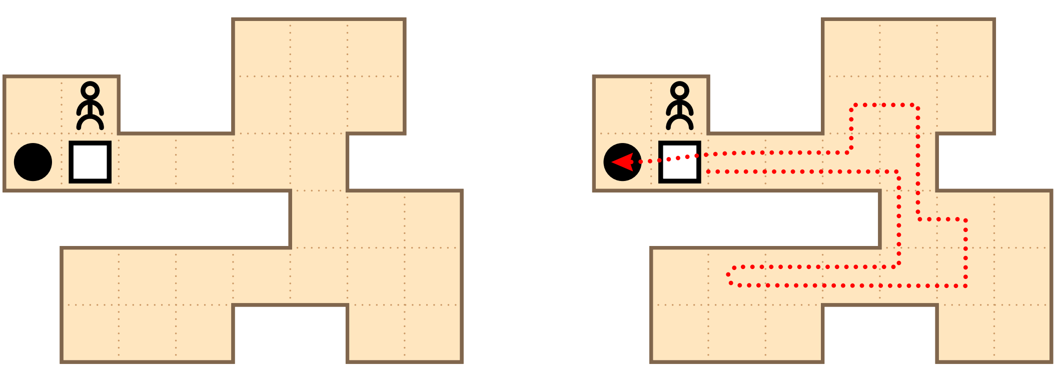

Figure 17. An example Sokoban challenge and its solution.

5.3 Sokoban

Figure 17 shows the well-known puzzle game Sokoban, in which the player pushes boxes around a maze to cover target holes [16]. This is another example of how not only the design of the game, but the design of each level, can be made to work for the player's benefit.

Sokoban's premise and basic mechanism – pushing boxes – is as simple as it gets. However, clever level design can bring out surprising interactions that require some creativity to solve. For example, the solution shown in Figure 17 (right) starts with the box as close as possible to its target destination, but with the player on the wrong side of it; the box must be pushed as far away from its target as possible then back again.

The design of this challenge is efficient in making the box travel as far as possible and requiring the use of *every* cell, and is also rather perverse in making the player go to all that effort just to return the box to its starting position for the final push. This level design exploits the game's characteristics to produce an engaging experience for the player.

6 Mental Bookkeeping

A common theme throughout this piece is to minimise the mental bookkeeping that players must perform. This section discusses ways that this can be achieved.

6.1 Lines of Action

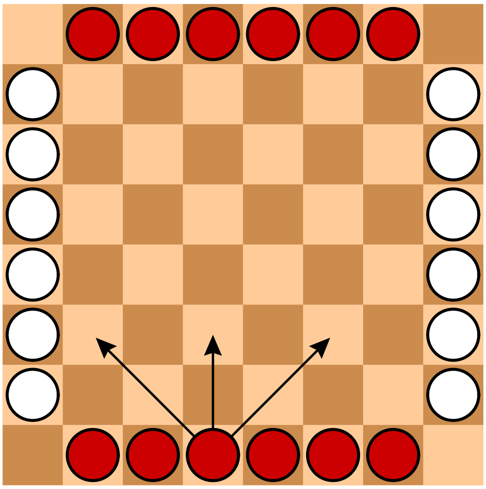

Figure 18. Opening moves in Lines of Action.

Claude Soucie's classic board game Lines of Action [17], shown in Figure 18, contains a number of movement rules:

- Pieces must move in an orthogonal or diagonal line a distance equal to the number of pieces in that line.
- Pieces can jump over friendly pieces but not land on them.
- Pieces can not jump over enemy pieces but can land on them (to capture).

This rule set has the potential to confuse. To determine the available moves, the mover must count the number of pieces along *every* line through *every* friendly pieces, then remember whether friendly pieces can jump over enemy ones or whether it is the other way around. So why has this game increased in popularity to become a classic and be well respected and widely played today?

I believe that this is because the movement rules exhibit an internal logical consistency that collapses to reduce their true complexity to almost nothing. Since pieces are only counted along the line of travel in each direction, then players can count them at the same time as evaluating potential landing sites along those lines with little additional mental work; with practice, counting pieces and determining landing sites becomes part of the same habitual action. To see this, consider the opening moves shown in Figure 18, and how it becomes obvious that there are two pieces along each potential direction of travel.

Further, it is standard in board games for pieces to land on enemy pieces to capture them, which gives the player a reference point for mentally consolidating the complementary jump and landing rules; you can kill an enemy but not a friend, so can jump over a friend but not an enemy. The movement rules thus reduce to two basic mental checks for players to perform. The game also benefits from the chequered board design, which makes diagonal lines easier to follow.

6.2 Ultima

Robert Abbott's game Epaminondas [3] introduces a similar type of linear piece movement, in which *phalanxes* – consecutive lines of friendly pieces – move along their line as a unit, up to a number of squares equal to their length. Figure 19 shows the game in its starting position.

As is the case with Lines of Action, moves in Epaminondas are easy to visualise as the distance count and direction calculations occur along the same axis and can be done at a glance. In fact, moves in Epaminondas are easier for players to visualise than moves in Lines of Action, as short lines of consecutive pieces are easier to count in a glance than counting all pieces along a given axis. Epaminondas is particularly interesting for the purposes of this discussion, as it was invented by Abbott in direct response to a perceived lack of clarity in his earlier game Ultima [18].

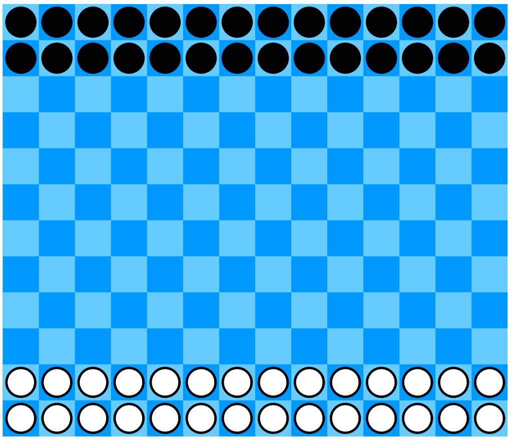

Figure 19. Epaminondas starting position.

Ultima is a Chess variant in which the pieces have unusual and reasonably complex behaviours, which players found confusing:

> *. . . the resulting game is so complex that it is difficult to see more than one or two moves ahead, and too many pieces are captured simply by surprise attack.* [3, p. 85]

Attempts were made to simplify the game for players by illustrating each piece with its movement details to 'embed the rules', as described in [2], but without much success. Ultima has since been disowned by Abbott, who found a solution to the problem of clarity by using uniform pieces for each player and instead using local relationships among pieces to define their movement in Epaminondas.

This further illustrates the difference between 'embedding the rules' and 'making the design do the work'. Complicating the pieces with explicit movement instructions did not help as much as a complete redesign that simplified the pieces down to uniform stones; embedding the rules still made the player do the work in this case.

6.3 Quantum Leap

The recently invented game of Quantum Leap[10] is played on the hexagonal grid shown in Figure 20. Players take turns jumping one of their pieces along any of the six diagonal axes, by a distance equal to its number of adjacent friendly pieces, to land on an enemy piece (which is captured).

The movement of pieces is dictated by their relationships with other pieces, as in Lines of Action and Epaminondas. However, there is a key difference; in these previous games, the distance and direction are both determined along the same axis (line of travel), whereas in Quantum Leap they are determined on independent axes (adjacent neighbourhood and line of travel). This added layer of complexity can make moves harder to visualise, as move processing involves a two-step process for each piece: 1) count its friendly neighbours, then 2) check this distance along each axis.

To get a feel for this process, identify the legal moves from the white piece marked '?' in Figure 20.[11] This is not an overly taxing task for a single piece, but does require some concentration to get right on the somewhat confusing hexagonal grid. But consider the mental effort required to apply this process to *all* white pieces, and to visualise future moves from the resulting board states, and one starts to appreciate the difficulty of planning ahead in this game.

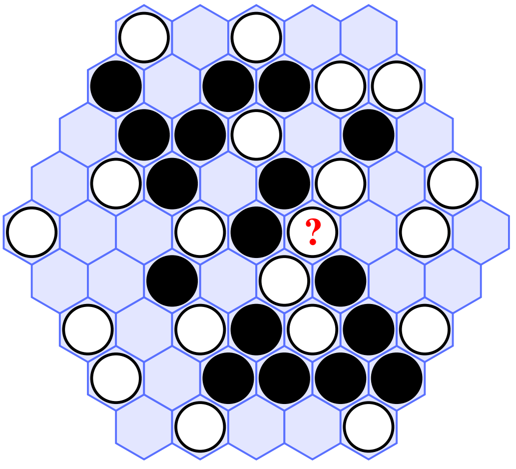

Figure 20. Where can the marked piece move?

To address this problem, a variant was tested in which pieces were instead pushed a distance equal to the number of consecutive friendly pieces lined up behind them along the direction of travel. This placed the distance and direction calculations along the same axis to make moves easier for the player to calculate, but unfortunately led to a more restricted game; edge pieces were restricted to the edges and corner pieces had no possible moves.

[10] http://www.nestorgames.com/rulebooks/QUANTUMLEAP_EN.pdf
[11] There are three.

6.4 Iqishiqi

The game of Iqishiqi, designed by João Pedro Neto and Bill Taylor, uses another push mechanism based on group connectivity.[12] Players take turns placing a piece of the same colour, to expand a connected group of pieces that is in line-of-sight of a single neutral piece of another colour along any of the six cardinal directions. That neutral piece is then pushed along that line a number of cells equal to the group size; the mover chooses which direction if there is more than one line-of-sight.

For example, Figure 21 shows a board state in which the mover has just placed the piece marked '+' to make a group of size 4, to push the neutral red piece four cells in either of the directions shown. If White is making the move, they will choose the upwards line that pushes the neutral piece to the white board edge, to win the game.

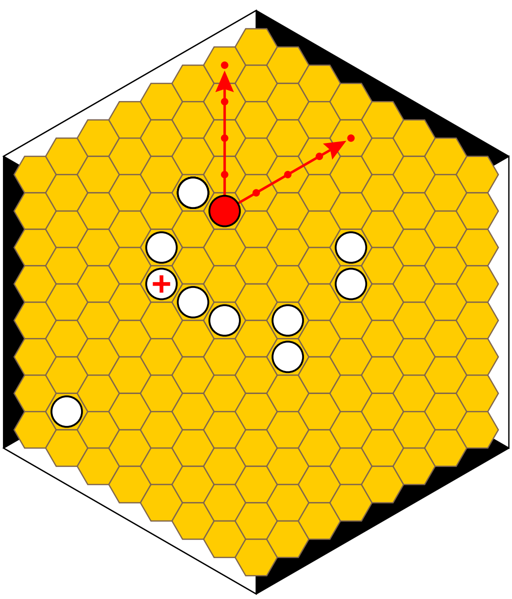

Figure 21. A group push in Iqishiqi.

This movement mechanism is close in spirit to the Quantum Leap mechanism but is less confusing to apply:

- Moves are limited to those cells adjacent to groups in line-of-sight of the neutral piece, rather than all friendly pieces.
- Uniform group size is easier to calculate than differentiated neighbour counts.
- Sharing a single piece colour is simpler than differentiated colours in general.

These factors are subtle – and debatable – but combine to reduce the mental workload when identifying legal moves.

7 Counterexamples

A good way to highlight the benefit of making the design do the work is to study some counterexamples in which this principle is violated.

7.1 Quoridor

In the game Quoridor, players aim to move their pawn to the far side of a square 9×9 board, taking turns either moving their pawn a step or adding one of 20 wall segments to block the opponent.[13] The game contains a special rule: *players can not place a wall segment that would cut off all of the opponent's remaining paths to victory.*

This special rule presumably provides a more balanced game, prolonging the contest and avoiding trivial wins in which players cut the opponent off prematurely, and avoids the undesirable situation of one player having no chance of winning while the opponent plays out their remaining moves. However, it also adds strategic depth to the game.

Consider the situation shown in Figure 22, with White to play and win. White has exactly one winning move: placing a wall at *a* allows a win in three moves. If White plays anywhere else, then Black can place a wall at *b* to force White to backtrack through a much longer path, safe in the knowledge that the Black piece can not be blocked and will win in three moves.

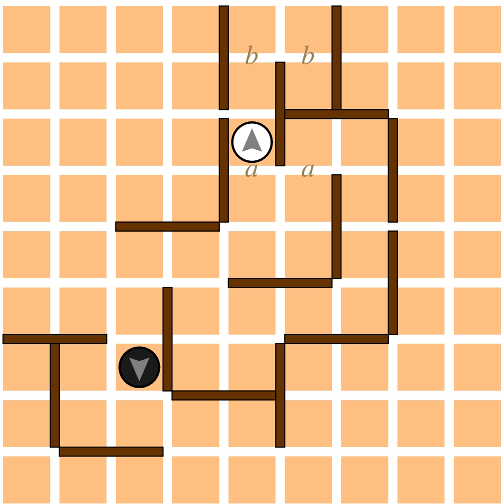

Figure 22. White to play and win in Quoridor.

[12] http://www.nestorgames.com/rulebooks/IQISHIQI_EN.pdf
[13] http://en.gigamic.com/game/quoridor

The special 'must allow an enemy path' rule is an example of making the player do the work, as it is an additional rule that players must remember and apply when planning moves. However, visualising paths is an intuitive task that the human brain is adept at – except for particularly complex situations – and this additional rule does not represent an undue amount of mental calculation in practice. The advantages of including this rule obviously outweighed the disadvantages, and it is in fact one of the most interesting aspects of the game.

7.2 Red

In the game of Red, players add square pieces in two different sizes, with differently coloured backgrounds and foreground shapes. Players aim to connect groups of tiles with their background colour and with their foreground colour. [14]

Red also contains a special rule: *tiles can only be placed if they are adjacent to at least one existing small tile.* This rule is necessary to stop players 'hiding' their pieces behind larger tiles for easy points. For example, the move shown in Figure 23 (left) cannot be played, as the tile being placed would not lie adjacent to any small tiles.

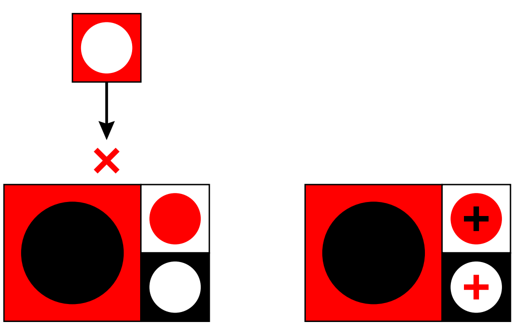

Figure 23. Red problem and a possible solution.

This special rule is another example of making the player do the work. However, there is an additional problem, as the rule is not intuitive and players keep forgetting it. This has necessitated revising the Red rule book to highlight this special rule, but this non-intuitive rule still troubles players and affects the game's otherwise excellent clarity.

Is there a simple solution to this problem? Figure 23 (right) shows one option; marking small tiles with a '+' sign as a visual cue that these are tiles that can be added to. However, this would detract from the visual clarity of the game, which is at odds with its designer's aesthetic vision.

7.3 Rithmomachy

I conclude with a notable case for making the design do the work. There has recently been something of a revival in historical board games. . . but not this one! There is a reason why most readers will not have heard of Rithmomachy.

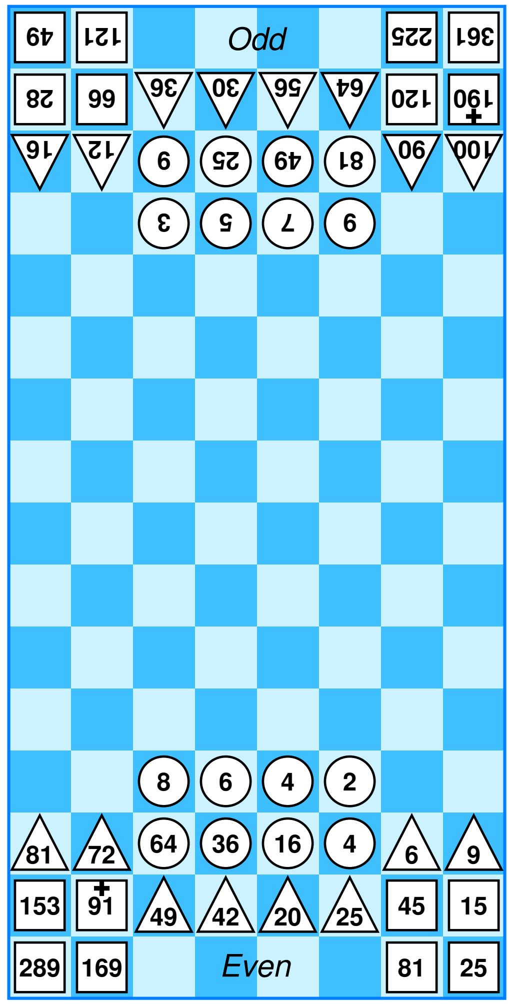

Figure 24. The game of Rithmomachy.

The mere sight of the imposing board and starting configuration of pieces shown in Figure 24 would be enough to give pause to even the most hardcore gamer. To quote noted game historian H. J. R. Murray [19, p. 227]:

> *It was the dullness and difficulty of this game that killed it.*

To appreciate the extent of the problem, consider the following fragments from just a few of the game's various capture rules [19]:

[14] http://www.nestorgames.com/rulebooks/RED_EN.pdf

> *Addition:* Two or more men can both be played by a legal move to a cell occupied by an enemy man, and the sum of the numbers on these men equals the number on the enemy man...

> *Multiplication:* A man numbered n is x cells distant along an orthogonal or diagonal direction from an enemy man with number $x \times n$ and no man intervenes between them...

> *Subtraction:* Two men can be played by a legal move to a cell occupied by an enemy man, and the difference of their numbers equals the number of the enemy man...

> *Division:* A man numbered n is x cells distant along an orthogonal or diagonal direction from an enemy man with number x/n...

Every turn would have been an exercise in laborious mental number crunching just to determine which moves were allowed, resulting in perhaps the worst clarity of any known abstract board game. Planning ahead even a move or two would have been beyond the skill of all but the most gifted and dedicated of players.

This game was evidently designed as a tool for teaching elementary mathematics to players, with little regard for notions such as elegance, clarity or fun. The design made the player do the work – and a *lot* of work – every turn.

Murray describes Rithmomachy as a 'highly artificial arithmetical game' and the only known game of the Middle Ages to have perished entirely, despite being played for hundreds of years. However, Ingo Althöfer points out that this is no longer strictly true, as a small number of players are now interested in the game from a historical perspective.[15] Modern sets are typically accompanied with cards showing the important numerical relationships, to ease the burden on the player. The game would need to be redesigned for a modern audience – with a smaller board and simpler rules – if it were widely released today.

8 Computational Approach

Computer scientist Spyridon Samothrakis points out that another way of viewing this concept of making the design do the work, or designing for effect, is to understand it as designing games that provide *features* that are easy for the human brain to interpret.[16] This is related to the brain's capacity for *chunking* raw information into more useful higher-level conceptual units [20]. If the player is able to mentally chunk trivial aspects of a game into more meaningful features, which can then be used for strategic planning, then this should make the game easier to play and more interesting for the player.

Samothrakis suggests that such an approach could lead to formal notions of design for effect, and proposes the following categories of features as a starting point:

- Reward: *Does this action score a point?*
- Transition: *How will this action affect the game state?*
- State: *Given a state, where am I in the game?*
- Action: *What actions are available?*
- Static value: *How good is this state?*
- Dynamic value: *Will this action improve my position?*

9 Conclusion

I hope that I have demonstrated through this discussion, and the related examples, the importance of making the design do the work rather than the player, especially for strategy games. This is more a mindset than a practical procedure as there are no hard and fast guidelines: sometimes rules need to be removed and sometimes added; sometimes equipment needs to be simplified and sometimes embellished, and so on. The designer is removing themself from the equation and letting the design speak for itself.

The main purpose of this piece is to raise awareness of such issues in the designer's mind. Making the design do the work – rather than the player – has many benefits. It allows more elegant games that are easier to play, in which players can focus on the strategic battle at hand rather than the inner mental battle of simply interpreting and applying the game's rules.

Acknowledgements

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[15] Personal correspondence.
[16] Personal correspondence.
[17] http://www.apronus.com/chess/wbeditor.php

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Gloop Challenge #7

Pack the tiles on the right into the grid to form a single closed contour. Gloop is described on pp. 31–32.